Fail-Safe circuit for gas valves

This application claims priority to PCT/EP2005/002855,
filed on March 17, 2005, which claims priority to
5   DE102004016764.8 filed on April 1, 2004.

Technical Field
The invention relates to a fail-safe circuit for gas
valves.
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Background
Control devices for gas valves must be fail-safe. If the
state of the control device is undefined, then it must be
guaranteed that in this undefined state a gas valve
15   controlled by the control device does not open. If, for
example, a microprocessor is used as the control device
for gas valves, then the use of a fail-safe circuit may
help ensure that the whole arrangement is fail-safe.

20   Recently, piezo-operated gas valves have been used,
particularly in low-voltage applications such as water
heaters without a mains connection. The piezo-operated
gas valves are often controlled by a control device in
the form of a microprocessor. In such low-voltage
25   applications, the supply voltage is often approximately 3
volts, which can be provided by a battery. However, a
voltage of typically at least 150 volts is required to
open the piezo-operated gas valves. Accordingly, a fail-
safe circuit is often desirable for low-voltage
30   applications of this kind, which, on the one hand,
provides an output voltage of at least 150 volts to open
the piezo-operated gas valves from a low supply voltage
of approximately 3 volts, and, on the other, only
generates the output voltage required to open the piezo-
35   operated gas valves if the control device, often in the
form of a microprocessor, is in a defined state to open
the gas valves.

Summary

According to one illustrative embodiment the present
invention, a fail-safe circuit includes at least one

5   input that can be connected to a control device and at
least one output that can be connected to a gas valve,
where the fail-safe circuit only supplies an output
voltage that is required to open a gas valve to the, or
to each output, if an input signal containing at least

10   two different, successive frequency signals is applied by
the control device to an input of the fail-safe circuit.

In some cases, a fail-safe circuit is created for gas
valves, in particular for piezo-operated gas valves,

15   which, on the one hand, is able to provide an output
voltage of more than 150 volts that is required to open
piezo-operated gas valves from a supply voltage of only
approximately 3 volts, and, on the other, only provides
this output voltage required to open the piezo-operated

20   gas valves if the control device is in a defined state to
open the gas valves. One illustrative fail-safe circuit
may be characterized by a simple design and can be
implemented cost-effectively.

25   According to one illustrative embodiment, the fail-safe
circuit may include a charging circuit and a voltage
transformer circuit, but this is not required. The
charging circuit may have at least one capacitor, where
the charging circuit charges the one or more capacitor in

30   the charging circuit when a first frequency signal is
applied or is present in the input signal. On the other
hand, when a second frequency signal is applied or is
present, the one or more capacitors in the charging
circuit discharge. In some cases, the voltage transformer

35   circuit produces an output voltage that is required to
open the gas valve from a supply voltage when the second
frequency signal is applied or is present in the input

signal. The voltage transformer circuit may have at least one capacitor, which charges when the second frequency signal is present in the input signal, and which discharges when the first frequency signal is present in

5   the input signal, and hence maintains the output voltage required to open the gas valve more or less unchanged for a period of time.

Brief Description

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The invention may be more completely understood in consideration of the following detailed description of an illustrative embodiment of the present invention in connection with the accompanying drawings, without being

15   restricted to this or other illustrative embodiment, in which:

Fig. 1   shows a circuit diagram of a fail-safe circuit
         for gas valves according to one illustrative

20   embodiment of the present invention.

Description

An illustrative embodiment of the present invention is

25   described in greater detail below with reference to Fig. 1.

Fig. 1 shows a fail-safe circuit 10 for gas valves according to one illustrative embodiment, in particular

30   for low-voltage applications. Possible examples of such low-voltage applications are water heaters without a mains connection in which piezo-operated gas valves are used. In such low voltage applications, a supply voltage is typically provided from a battery or from a generator

35   integrated within the water circulation, the supply voltage in such applications is often about 3 volts. In Fig. 1 the supply voltage is identified with V_{BAT}.

In the illustrative embodiment of Figure 1, the fail-safe
circuit 10 has an input to which a control device
sometimes in the form of a microprocessor can be
5   connected, and two outputs 12 and 13, from which a supply
voltage +/- V_{OUT} is output for a gas valve. Depending on
the signal from the control device, which is applied to
the input 11 of the illustrative fail-safe circuit 10 of
Fig. 1, the circuit may generate the output voltage V_{OUT}
10   that is necessary to open the gas valve using the supply
voltage V_{BAT}, which is approximately 3 volts, namely only
when an input signal containing at least two different
successive frequency signals is supplied by the control
device to the input 11 of the fail-safe circuit 10.
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The illustrative fail-safe circuit 10 of Fig. 1 has a
charging circuit 14 and a voltage transformer circuit 15.
The charging circuit 14 and the voltage transformer
circuit 15 contain the components enclosed by chain-
20   dotted lines in Fig. 1.

The charging circuit 14 of the illustrative fail-safe
circuit 10 includes a capacitor 16, where two diodes 17
and 18 are connected in parallel with the capacitor 16. A
25   resistor 19, which is connected to the input 11 of the
fail-safe circuit 10 via a capacitor 20, is connected
between the two diodes 17 and 18.

As can be seen in the illustrative embodiment of Fig. 1,
30   a transistor 22 is connected to the input 11 of the fail-
safe circuit 10 via a resistor 21, the transistor 22
being designed as a bipolar transistor, namely as an NPN
transistor in the illustrative embodiment. The base of
the transistor 22 is connected to the input 11 of the
35   fail-safe circuit 10 by means of the resistor 21.
Connected to the capacitor 16 of the charging circuit 14
is a further resistor 23, which in turn is linked to the

collector of the transistor 22 and the base of a
transistor 24 of the voltage transformer circuit 15. The
transistor 24 is in turn designed as a bipolar
transistor, namely as an NPN transistor in the

5   illustrative embodiment.

In the illustrative embodiment of Fig. 1, the emitters of
the two transistors 22 and 24 are connected together. As
well as the transistor 24 already mentioned, the base of

10   which is connected on the one hand to the collector of
the transistor 22 and, on the other, by means of the
resistor 23 to the capacitor 16 of the charging circuit
14, the voltage transformer circuit 15 furthermore
contains a comparator 25, a coil 26, a diode 27, a

15   capacitor 28, a resistor 29 and a further transistor 30.
The transistor 30 is designed as a field effect
transistor or a MOSFET transistor in the illustrative
embodiment.

20   As can be seen from Fig. 1, the coil 26 is connected on
the one hand to the supply voltage V_{BAT} and, on the other,
to the so-called drain of the transistor 30, which is
designed as a self-blocking field effect transistor in
the illustrative embodiment. An anode of the diode 27 is

25   connected between the coil 26 and the drain of the MOSFET
transistor 30, whereas the cathode of the diode 27 is
connected to the output 12. The source of the MOSFET
transistor 30 is shown connected to the output 13, while
the capacitor 28 of the voltage transformer circuit 15 is

30   shown connected between the outputs 12 and 13 of the
fail-safe circuit 10. As can also be seen from Fig. 1,
the output of the comparator 25 connects to the gate of
the MOSFET transistor 30 while the input of the same is
connected to the collector of the bipolar transistor 25.

35   Furthermore, the collector of the transistor 24 is
connected by means of the resistor 29 to the coil 26 and
thus to the supply voltage V_{BAT}.

As already mentioned, the fail-safe circuit 10 may only
generate an output voltage of over 150 volts that is
required to open the gas valve at the outputs 12, 13 if a
5   signal containing at least two different successive
frequency signals is provided by the control device at
the input 11 of the fail-safe circuit 10. In this case, a
defined operating state of the control device for opening
the gas valve exists.
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In the illustrative embodiment, the input signal may
contain two frequency signals, namely a first frequency
signal with a frequency of about 500 kHz and a second
frequency signal with a frequency of about 10 kHz, which
15   are present or are applied successively in the signal
provided by the control device in such a way that a time
period of about 30 milliseconds with the first frequency
signal of about 500 kHz is respectively followed by a
time period of about 100 milliseconds with the second
20   frequency signal of about 10 kHz.

The illustrative fail-safe circuit 10 of Fig. 1 may work
in such a way that when the first frequency signal of
about 500 kHz is applied or is present at input 11, the
25   charging circuit 14 charges the capacitor 16 of the same.
While the second frequency signal of about 10 kHz is
applied to the input 11, the capacitor 16 of the charging
circuit is not charged but rather a discharge of the
capacitor 16 takes place via the resistor 23 and the base
30   of the transistor 24. The transistor 24 of the voltage
transformer circuit 15 is then conductive if a current
flows to its base due to the discharge of the capacitor
16.

35   During the time period for which the first frequency
signal of about 500 kHz is applied to the input 11, a
high output voltage that is required to open the gas

valve cannot be generated by the voltage transformer
circuit 15 due to the high losses, in particular in the
coil 26 and in the MOSFET transistor 30 of the voltage
transformer circuit 15. Rather, this high output voltage

5   is only generated when the second frequency signal with a
frequency of about 10 kHz is applied to the input 11.
When the second frequency signal of about 10 kHz is
applied to the input 11, an output voltage V_{OUT} of more
than 150 volts that is required to open the piezo-

10   operated gas valve is generated from the supply voltage
V_{BAT} by the voltage transformer circuit 15, and the
capacitor 28 of the voltage transformer circuit 15 is
charged.

15   If a time period of about 100 milliseconds, in which the
second frequency signal with a frequency of about 10 kHz
is applied, is followed by a time period of about 30
milliseconds with the first frequency signal with a
frequency of about 500 kHz, then the capacitor 28 of the

20   voltage transformer circuit 15 discharges and essentially
maintains the output voltage of more than 150 volts that
is required to open the gas valve. The capacitor 28
discharges via the high resistance of the gas valve
during the time period in which the first frequency

25   signal with the frequency of about 500 kHz is applied.

The specific design of the circuit described above is
incumbent upon the person skilled in the art addressed
here. In the particularly preferred exemplary embodiment

30   in which an output voltage V_{OUT} of about 250 volts is to
be provided for opening the gas valve from the supply
voltage V_{BAT} of about 3 volts, the capacitance of the
capacitor 28 is preferably 1 μF, the capacitance of the
capacitor 16 is about 10 μF and the capacitance of the

35   capacitor 20 is about 220 pF. The resistance of the gas
valve connected to the outputs 12 and 13 can be assumed
to be 10 MΩ, the resistor 21 is preferably chosen to be 1

MΩ, the resistor 19 to be 1 kΩ and the resistor 29 to be 10 kΩ. The resistor 23 preferably has a value of 22 kΩ. The coil 26 preferably has an inductance of 1 mH. With these values, the discharge time of the capacitor 28 is

5   about 10 seconds from which it immediately follows that an output voltage that is required to open the gas valve can also be provided at the outputs 12 and 13 during the time period of 30 milliseconds in which the first frequency signal of about 500 kHz is applied to the input

10   11.

List of references

	10	Fail-safe circuit
5	11	Input
	12	Output
	13	Output
	14	Charging circuit
	15	Voltage transformer circuit
10	16	Capacitor
	17	Diode
	18	Diode
	19	Resistor
	20	Capacitor
15	21	Resistor
	22	Transistor
	23	Resistor
	24	Transistor
	25	Comparator
20	26	Coil
	27	Diode
	28	Capacitor
	29	Resistor
	30	Transistor